AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS

BACKGROUND OF THE INVENTION

This invention relates generally to electrical switches and, more particularly, to automatic transfer switches and control thereof.

Many businesses use transfer switches for switching power sources, for example, from a public utility source to a private secondary supply, automatically within a matter of seconds. Critical load businesses, such as, for example, hospitals, airport radar towers, and high volume data centers are dependent upon automatic transfer switches to provide continuous power. Transfer switches typically utilize a plurality of contacts that can be open or closed.

Typically, automatic transfer switches are controlled using relay logic, programmable logic controllers (PLCs) or embedded controllers. In known systems, the embedded controller monitors the public utility power source for a fault condition. Upon recognizing any one of a number of faults with the utility power, the embedded controller is configured to switch in the secondary source of power, typically a generator, via the transfer switches.

Known automatic transfer switch controllers incorporate external components to accomplish the control task and require hardware and software redesigns when making input/output (I/O) changes. Further, known automatic transfer switch controllers are unable to communicate with external devices for software selection of options.

Accordingly, it would be desirable to provide systems for automatic transfer switch control which eliminate external components and provide flexibility for I/O circuit redesign. It would be further desirable to have an automatic transfer switch controller with a communications interface to enable and select software options from an external device.

BRIEF SUMMARY OF THE INVENTION

An automatic transfer switch controller includes a power supply circuit to regulate and filter input power. Also included is a transformer to convert utility and generator power sources into power supply voltages and voltage sensing sources for the controller. A voltage sense signal conditioning circuit is included as is a solenoid driver circuit used to drive automatic transfer switch solenoids. The controller uses an embedded microcontroller to monitor utility and generator voltages which is interfaced to a user interface for operator entry of instructions. An LED indicator interfaced to said microcontroller is used to indicate operator entry of instructions at the operator interface.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified schematic showing electrical routing within an automatic transfer switch system; and

Figure 2 is a block diagram of an automatic transfer switch controller.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a simplified schematic diagram 10 showing electrical routing within an automatic transfer switch (ATS) system. Included in diagram 10 are a utility source 12 and a generator source 14. Each of utility source 12 and generator source 14 are routed through circuit breakers 16 to a transfer switch 18. Transfer switch 18 is configured to route electrical power from utility source 12 through transfer switch 18 to a main breaker panel 20, through which electricity is distributed throughout a facility. Transfer switch 18 is further configured with a controller (not shown) to monitor the power from utility source 12 for power quality, for example voltage, power factor, electrical noise and the like. When the transfer switch controller senses a problem with power quality, based upon preset limits, the transfer switch controller commands transfer switch 18 to switch to electrical power from generator source 14, on a temporary basis, until the transfer switch controller senses that the power quality from utility source 12 has returned to an acceptable level.

Figure 2 is a block diagram of an automatic transfer switch controller 40. Controller 40 includes a microcontroller 42, a memory 44, a user interface 46, a power input section 48, an output section 50 which is configured to command one or more transfer switches 18 (shown in Figure 1) to go to power from a generator source or to return to a utility source of power. Controller 40 also includes a configuration section 52, a communications port 54 and a multi-function input/output (I/O) port 56 described below in more detail.

The term microcontroller, as used herein, also refers to microprocessors, reduced instruction set circuits (RISC), application specific integrated circuits (ASICs), logic circuits, and any other circuit or processor capable of executing the programs described above.

Controller 40 is a low cost, high performance ATS controller with software selectable options. In one exemplary embodiment, software options are to be enabled or disabled through the use of a factory configuration program via port 54, which is for example, an RS232 port.

Controller 40 is configured with external connections (not shown in Figure 2) to allow for adaptation of multiple function input/output (I/O) boards. I/O boards give controller 40 a modular configuration where different options can be made available to the end user if needed.

In one exemplary embodiment, functions of controller 40 are implemented on a main control circuit board which includes control and conditioning circuits as described below.

Power input section 48 includes transformers to convert power from utility source and generator source 14 (both shown in Figure 1) into power supply voltages for powering controller 40 and into voltages to be sensed by controller 40. Power input section 48 regulates and filters raw supply voltages from the transformers before it is applied to the main control board of controller 40 and any optional I/O boards such that correct operating voltages and currents are applied to such boards.

Power input section 48 further includes a voltage sense signal conditioning circuit which uses low pass filtering techniques to remove all unwanted noise from the raw voltage supply before it is applied to analog-to-digital converter (ADC) pins on microcontroller 42. Filtering allows controller 40 to correctly sense voltage and frequency when utility source 12 or generator source 14 contain large amounts of harmonic distortion.

In another exemplary embodiment of controller 40, output section 50 is configured as a solenoid driver circuit which includes two options of solenoid drivers, both of which are implemented on the main control board. A first solenoid driver option is configured with on-board relays when the utility and generator power sources are 240Vac and below. A second solenoid driver option is configured with solid state devices when the utility and generator power sources are greater than 240Vac, but less than 600 Vac. The solenoid driver circuit is used to control the power supplied to an ATS drive solenoid which causes swithcing from one electrical power source to another in transfer switch 18 (shown in Figure 1).

Using user interface 46 a user can momentarily energize a normal output causing the ATS to transfer to normal position, the position where utility power is used. Momentarily energizing an emergency output causes the ATS to transfer to the position where generator power is used. In order to protect the ATS drive solenoid from damage, a solenoid saver scheme is implemented in controller 40 which controls the maximum on time and the number of tries a drive solenoid can be energized for before shutting down the drive circuit and initiating a diagnostic mode.

All functions on the main control board are controlled by microcontroller 42 which uses custom written firmware to monitor the utility and generator voltages and frequency, monitor user interface updating indicator LEDs on user interface 46, perform real time clock functions, monitor ATS position and control the ATS. Microcontroller 42 also monitors and controls all external I/O connections used to control any auxiliary I/O boards. In a further embodiment, controller 40 is configured with a generator cool down timer, a generator warmup timer, a loss of power delay timer, a generator fail-to-start timer, a generator crank timer, a generator

pause timer, a generator overload timer and an utility stabilization before switchback timer.

Controller 40 includes a configuration section 52. In one embodiment, configuration section 52 includes a jumper panel. Jumpers are installed by a user to select one of a seven, 14, 21, or 28 day cycle for a built in ATS exerciser. The exerciser period can be adjusted for seven, 14, 21, or 28 days by selecting the appropriate jumpers setting located on the main control board.

Configuration section 52 further includes jumper selectable voltage and frequency selections. The voltage controller 40 can sense is selectable from 120, 208, 220, and 240 Vac through the use of the correct jumper settings. Voltage ranges in the 380, 415, 440, and 480Vac are also selectable, but require that a different transformer be used in controller 40. Jumpers are also available for frequency selections of 50 Hz and 60 Hz.

Controller 40 is further configured with a passive load shed option which, when coupled with a load shed I/O option board will disconnect certain high kilowatt loads before the controller transfers loads from utility power to generator power, thereby preventing unwanted loads from over loading generator 14.

In another embodiment, controller 40 is configurable with a generator control board (not shown) option which is an optional I/O board that connects to the main control board and contains I/O functions which are accessible at I/O port 56. Examples of I/O functions include, but are not limited to oil pressure sensing, temperature sensing, and a set of dry contacts for starter motor control including a fuel/run contact output and a start contact output. When a generator control board is included in controller 40, a software control bit is enabled to allow access to the board I/O functions.

In still another embodiment, controller 40 is configurable with a three phase sense board (not shown). The three-phase sense board is an optional I/O board that expands controller 40 from single-phase voltage sensing to three-phase voltage

sensing on both utility and generator power sources. The three-phase sense board contains all of the necessary conditioning circuitry necessary for proper voltage and frequency detection.

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Controller 40 solves problems present in known controllers. Such problems include external relay transformer boxes separate form the controller, a need for an external exerciser clock and the ability to make I/O changes without complete redesign of the ATS controller. In addition, controller 40 locates all ATS control components and voltage conditioning components on a main control board, thereby allowing for other I/O functionality to be implemented on option boards as described above.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.